CLAIMS

What is claimed:

1. An apparatus for measuring the mass of an analyte molecule of an analyte sample by means of mass spectrometry, said apparatus comprising:

a spectrometer tube;

vacuum means for applying a vacuum to the interior of said tube;

electrical potential means within the tube for applying an accelerating electrical potential to desorbed analyte molecules from said analyte sample;

sample presenting means removably insertable into said spectrometer tube, for presenting said analyte sample in association with surface associated molecule for promoting desorption and ionization of said analyte molecules, wherein said surface molecule is selected from the group consisting of energy absorbing molecule, affinity capture device, photolabile attachment molecule and combination thereof;

an analyte sample deposited on said sample presenting means in association with said surface associated molecules; whereby at least a portion of said analyte molecules not consumed in said mass spectrometry analysis will remain accessible for subsequent chemical, biological or physical analytical procedures;

laser beam means for producing a laser beam directed to said analyte sample for imparting sufficient energy to desorb and ionize a portion of said analyte molecules from said analyte sample; and

detector means associated with said spectrometer tube for detecting the impact of accelerated ionized analyte molecules thereon.

2. A method in mass spectrometry to measure the mass of an analyte molecule, said method comprising the steps of:

derivitizing a sample presenting surface on a probe tip face with an affinity capture device having means for binding with an analyte molecule;

exposing said derivitized probe tip face to a source of said analyte molecule so as to bind said analyte molecule thereto;

placing the derivitized probe tip with said analyte molecules bound thereto into one end of a time-of-flight mass spectrometer and applying a vacuum and an electric field to form an accelerating potential within the spectrometer;

striking at least a portion of the analyte molecules bound to said derivitized probe tip face within the spectrometer with one or more laser pulses in order to desorb ions of said analyte molecules from said tip;

detecting the mass of the ions by their time of flight within said mass spectrometer; and

displaying such detected mass.

3. The method according to claim 2, further comprising applying a desorption/ionization assisting matrix material to said probe tip face in association with said affinity capture device.

4. The method according to claim 3, further comprising removing said probe tip from said mass spectrometer;

performing a chemical or biological procedure on said portion of said analyte molecules not desorbed to alter the composition of said portion of said analyte molecules not desorbed;

reinserting said probe tip with said altered analyte molecules thereon; and

performing subsequent mass spectrometry analysis to determine the molecular weight of said altered analyte molecules.

5. The method according to claim 2 wherein said affinity capture device is chemically bonded to said face of said probe tip.

6. The method according to claim 2 wherein said affinity capture device is physically adhered to said face of said probe tip.

7. The method according to claim 2 wherein said affinity capture device is adapted to chemically bond to said analyte molecules.

8. The method according to claim 2 wherein said affinity capture device is adapted to biologically adhere to said analyte molecules.

9. The method according to claim 2 wherein said analyte molecules are biomolecules and said affinity reagent is adapted to selectively isolate said biomolecules from an undifferentiated biological sample.

10. The method according to claim 3 wherein said matrix materials are in the weakly acidic to strongly basic pH range.

11. The method according to claim 3 wherein said matrix materials have a pH above 6.0.

12. The method according to claim 2 wherein said face of said probe tip is formed of an electrically insulating material.

13. A method of measuring the mass of analyte molecules by means of laser desorption/ionization, time-of-flight mass spectrometry in which an energy absorbing material is used in conjunction with said analyte molecules for facilitating desorption and ionization of the analyte molecules, the improvement comprising:

presenting the analyte molecules on or above the surface of the energy absorbing material, wherein at least a portion of the analyte molecules not desorbed in said mass spectrometry analysis remain chemically accessible for subsequent analytical procedures.

14. An apparatus for facilitating desorption and ionization of analyte molecules, said apparatus comprising:

a sample presenting surface; and

surface associated molecules, wherein said surface associated molecules are selected from the group consisting of energy absorbing molecule, affinity capture device, photolabile attachment molecule and combination thereof, said surface associated molecules associated with said sample presenting surface and having means for binding with said analyte molecules.

15. The apparatus according to claim 14 wherein said sample presenting surface comprises the surface of a probe tip for use in a time-of-flight mass spectrometry analyzer.

16. The apparatus according to claim 14 wherein said affinity capture device or photolabile attachment molecule is chemically bonded to said sample presenting surface.

17. The apparatus according to claim 14 wherein said affinity capture device is physically adhered to said sample presenting surface.

18. The apparatus according to claim 14 wherein said affinity capture device or photolabile attachment molecule is chemically bonded to said analyte molecules..

19. The apparatus according to claim 14 wherein said affinity capture device is adapted to biologically adhere to said analyte molecules.

20. The apparatus according to claim 14 wherein said analyte molecules are biomolecules and said affinity capture device or photolabile attachment molecule is adapted to selectively isolate said biomolecules from an undifferentiated biological sample.

21. The apparatus according to claim 14, further comprising a matrix material deposited on said sample presenting surface in association with said affinity capture device or photolabile attachment molecule.

22. The apparatus according to claim 21 wherein said matrix material is in the weakly acidic to strongly basic pH range.

23. The apparatus according to claim 21 wherein said matrix material has a pH above 6.0.

24. The apparatus according to claim 14 wherein said sample presenting surface is formed of an electrically insulating material.

25. A method for capturing analyte molecules on a sample presenting surface and desorbing/ionizing said captured analyte molecules from said sample presenting surface for subsequent analysis, said method comprising:

derivitizing said sample presenting surface with an affinity capture device or photolabile attachment molecule having means for binding with said analyte molecules;

exposing said derivitized sample present surface to a sample containing said analyte molecules;

capturing said analyte molecules on said derivitized sample presenting surface by means of said affinity capture device or photolabile attachment molecule; and

exposing said analyte molecules, while bound to said derivitized sample presenting surface by means of said affinity capture device or photolabile attachment molecule, to an energy or light source to desorb at least a portion of said analyte molecules from said surface.

26. A method for preparing a surface for presenting analyte molecules for analysis, said method comprising:

providing a substrate on said surface for supporting said analyte;

derivitizing said substrate with an affinity capture device or photolabile attachment molecule having means for selectively bonding with said analyte; and

a means for detecting said analyte molecules bonded with said affinity capture device or photolabile attachment molecule.

27. The method according to claim 26 comprising additionally the step of applying a detection material to said surface.

28. The method according to claim 27 wherein such detection material comprises a fluorescing species.

29. The method according to claim 27 wherein such detection material comprises an enzymatic species.

30. The method according to claim 27 comprising additionally wherein such detection material comprises a radioactive species.

31. The method according to claim 27 comprising additionally wherein such detection material comprises a light-emitting species.

32. The method of claim 25, further comprising, depositing a desorption/ionization assisting material to said sample presenting surface in association with said affinity capture device or photolabile attachment molecule.

33. The method of claim 25 wherein said energy source comprises a laser.

34. The method of claim 25 wherein an affinity capture device is used and said energy source comprises an ion source.

35. The method of claim 25 wherein a portion of said analyte molecules remain bound to said sample presenting surface after exposure to said energy source.

36. The method of claim 35, further comprising the steps of:

converting at least a portion of the analyte molecules remaining bound on said derivitized sample presenting surface to modified analyte molecules by a chemical, biological or physical reaction, wherein said analyte molecules remain bound to said derivitized sample presenting surface by means of said affinity capture device or photolabile attachment molecule; and

exposing said modified analyte molecules to an energy source so as to desorb at least a portion of said modified analyte molecules from said surface.

37. A sample probe for promoting desorption of intact analytes into the gas phase comprising:

a sample presenting surface; and

an energy absorbing molecule associated with said sample presenting surface, wherein said sample probe promotes desorption of an intact analyte molecule positioned on, above or between the energy absorbing molecules when said sample probe is impinged by an energy source.

38. The sample probe of claim 37, wherein the energy absorbing molecule is selected from the group consisting of cinnamamide, cinnamyl bromide, 2, 5-dihydroxybenzoic acid and α-cyano-4-hydroxycinnamic acid.

39. The sample probe of claim 37, wherein the sample presenting surface is selected from the group consisting of glass, ceramics, teflon coated magnetic materials; organic polymers and native biopolymers.

40. A sample probe for promoting desorption of intact analytes into the gas phase comprising:

a sample presenting surface; and

an affinity capture device associated with said sample presenting surface; wherein, when said sample probe is impinged by an energy source, said sample probe promotes the transition of an intact analyte molecule into the gas phase.

41. The sample probe of claim 40, wh rein the affinity capture device is selected from the group consisting of metal ions, proteins, peptides, immunoglobulins, nucleic acids, carbohydrates, lectins, dyes, reducing agents and combination thereof.

42. The sample probe of claim 40, wherein the sample presenting surface is selected from the group consisting of glass, ceramics, teflon coated magnetic materials; organic polymers and native biopolymers.

43. A sample probe for promoting desorption of intact analytes into the gas phase comprising:

a sample presentation surface; and

a mixture of at least two different molecules selected from the group consisting of an affinity capture device, an energy absorbing molecule and a photolabile attachment molecule associated with said sample presentation surface; wherein when an analyte is associated with said sample probe, said sample probe promotes the transition of the analyte into the gas phase when said sample probe is impinged by an energy source.

44. The sample of claim 43, wherein the analyte is selectively desorbed from the mixture after impingement by the energy source.

45. A sample probe for promoting of differential desorption of intact analyte into the gas phase, comprising:

a sample presentation surface; and

at least two different affinity capture devices associated with said sample presentation surface; wherein, when said sample probe is impinged by an energy source, said sample probe promotes the

transition of an analyte molecule into the gas phase at different rates depending on the affinity capture device associated with said analyte molecule.

46. The sample probe of claim 45, wherein the affinity devices are arranged in predetermined arrays.

47. The sample probe of claim 46, wherein the arrays selectively absorb a plurality of different analytes.

48. The apparatus with the sample probe of claim 40 for quantitating an analyte, wherein the position and quantity of affinity capture devices determines the quantity of analyte absorbed.

49. The apparatus according to claim 2, 14 or 21, wherein the binding is selective.

50. The apparatus according to claim 2, 14 or 21, wherein the binding is non-selective.

51. The method according to claim 3, 4 or 25, wherein the binding is selective.

52. The method according to claim 3, 4 or 25, wherein the binding is non-selective.

53. The sample probe according to claim 40, 41, 43 or 45, wherein the binding is non-selective.

54. The sample probe according to claim 40, 41, 43 or 45, wherein the binding is selective.

55. A sample probe for promoting desorption of intact analyte into the gas phase, comprising:

a sample presentation surface; and

a surface associated molecule, wherein said surface associated molecule can function both as an energy absorbing molecule and as an affinity capture device.

56. A sample probe for desorption of intact analyte into the gas phase, comprising:

a sample presentation surface; and

a surface associated molecule wherein said surface associated molecule is a photolabile attachment molecule having at least two binding sites, wherein at least one site is bound to the sample presentation surface and at least one site is available to bind an analyte and wherein the analyte binding site is photolabile.

57. A method in mass spectrometry to measure the mass of an analyte molecule, said method comprising the steps of:

derivitizing a sample presenting surface on a probe tip face with a photolabile attachment molecule (PAM), wherein said PAM has at least two binding sites, one binding site binds to the sample presenting surface and at least one binding site is available for binding with an analyte molecule;

exposing said derivitized probe tip face to a source of said analyte molecule so as to bind said analyte molecule thereto;

placing the derivitized probe tip with said analyte molecules bound thereto into one end of a time-of-flight mass spectrometer and applying a vacuum and an electric field to form an accelerating potential within the spectrometer;

striking at least a portion of the analyte molecules bound to said derivitized probe tip face within the spectrometer with one or more laser pulses in order to desorb ions of said analyte molecules from said tip;

detecting the mass of the ions by their time of flight within said mass spectrometer; and

displaying such detected mass.

58. The method according to claim 57, further comprising applying a desorption/ionization assisting matrix material to said probe tip face in association with said PAM.

59. The method according to claim 58, further comprising removing said probe tip from said mass spectrometer;

performing a chemical, biological or physical procedure on said portion of said analyte molecules not desorbed to alter the composition of said portion of said analyte molecules not desorbed;

reinserting said probe tip with said altered analyte molecules thereon; and

performing subsequent mass spectrometry analysis to determine the molecular weight of said altered analyte molecules.

60. The method according to claim 57 wherein said PAM is chemically bonded to said face of said probe tip.

61. The method according to claim 57 wherein said PAM is chemically bonded to said analyte molecule, and wherein said bond between the PAM and the analyte molecule is broken and the analyte molecule is released in a light dependent manner.

62. The method according to claim 57 wher in said analyte molecules are biomolecules and said PAM is adapted to selectively isolate said biomolecules from an undifferentiated biological sample.

63. The method according to claim 58 wherein said matrix materials are in the weakly acidic to strongly basic pH range.

64. The method according to claim 58 wherein said matrix materials have a pH above 6.0.

65. The method according to claim 57 wherein said face of said probe tip is formed of an electrically insulating material.

66. A method of measuring the mass of analyte molecules by means of laser desorption/ionization, time-of-flight mass spectrometry in which a photolabile attachment molecule (PAM) is used in conjunction with said analyte molecules for facilitating desorption and ionization of the analyte molecules, the improvement comprising:

presenting the analyte molecules on or above the surface of the PAM, wherein at least a portion of the analyte molecules not desorbed in said mass spectrometry analysis remain chemically accessible for subsequent analytical procedures.

67. A sample probe for promoting of differential desorption of intact analyte into the gas phase, comprising:

a sample presentation surface; and

at least two different photolabile attachment molecules associated with said sample presentation surface; wherein, when said sample probe is impinged by an energy source, said sample probe promotes the transition of an analyte molecule into the gas

phase at different rates depending on the photolabile attachment molecule associated with said analyte molecule.

68. The sample probe of claim 67, wherein the photolabile attachment molecules are arranged in predetermined arrays.

69. The sample probe of claim 68, wherein the arrays selectively absorb a plurality of different analytes.

70. A sample probe for promoting desorption of intact analytes into the gas phase comprising:

a sample presenting surface; and

a photolabile attachment molecule associated with said sample presenting surface; wherein, when said sample probe is impinged by an energy source, said sample probe promotes the transition of an intact analyte molecule into the gas phase.

71. The apparatus of claim 70 for quantitating an analyte, wherein the position and quantity of photolabile attachment molecule determines the quantity of analyte absorbed.

72. A method for biopolymer sequence determination comprising the steps of:

binding a biopolymer analyte to probe tip containing a sample presenting surface having a surface selected molecule selected from the group consisting of an energy absorbing molecule, an affinity capture device, a photolabile attachment molecule and a combination thereof;

desorption of biopolymer analyte in mass spectrometry analysis, wherein at least a portion of said biopolymer is not desorbed from the probe tip;

analyzing the results of the desorption modifying the biopolymer analyte still bound to the probe tip; and

repeating the desorption, analyzing and modifying steps until the biopolymer is sequenced.

73. The method of claim 72, wherein the biopolymer is selected from the group consisting of protein, RNA, DNA and carbohydrate.